
1 Introduction

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Worldwide declines in managed and non-managed pollinators have led to an increased global dialogue and focus concerning the potential factors that may be causing these declines. Although a number of factors have been hypothesized as potential contributors to pollinator declines, at this time, no single factor has been identified as the cause. The available science suggests that pollinator declines are a result of multiple factors which may be acting in various combinations. Research is being directed at identifying the individual and combined stressors that are most strongly associated with pollinator declines. Pesticide use is one of the factors under consideration.

In an effort to further the global dialogue, the Society of Environmental Toxicology and Chemistry (SETAC) held a Pellston Workshop¹ to explore the state of the science on pesticide risk assessment for pollinators. The proposal for this SETAC Workshop was developed by a steering committee (hereafter referred to as the Steering Committee) comprised of members from the government and nongovernmental organizations who were interested in advancing the science to understand the effect of pesticides on nontarget insects. Workshop participants were tasked to advance the current state of the science of pesticide risk assessment by more thoroughly vetting quantitative and qualitative measures of exposure and effects on the individual bee, and where appropriate, on the colony. In doing so, the Workshop aimed to synthesize the global understanding and work that has, thus far, taken place, and to move toward a harmonized process for evaluating and quantitatively characterizing risk to pollinators from exposure to pesticides; and to identify the data needed to inform that process. The Workshop focused on four major topics:

1. design and identify testing protocols to estimate potential exposure of bees to pesticide residues in pollen and nectar, as well as exposure through other routes;
2. design and identify testing protocols to measure the effects of pesticides on developing brood and adult honey bees at both the individual and the colony levels;
3. propose a tiered approach for characterizing the potential risk of pesticides to pollinators; and
4. explore the applicability of testing protocols, used for honey bees (*Apis* bees), to measure the effects of pesticides and pesticide risk to other non-*Apis* bee species.

¹ The first Pellston Workshop was held in 1977 to address the needs and means for assessing the hazards of chemicals to aquatic life. Since then, many workshops have been held to evaluate current and prospective environmental issues. Each has focused on a relevant environmental topic, and the proceedings of each have been published as a peer-reviewed or informal report. These documents have been widely distributed and are valued by environmental scientists, engineers, regulators, and managers because of their technical basis and their comprehensive, state-of-the-science reviews. The first four Pellston workshops were initiated before the Society of Environmental Toxicology and Chemistry (SETAC) was effectively functioning. Beginning with the 1982 workshop, however, SETAC has been the primary organizer and SETAC members (on a volunteer basis) have been instrumental in planning, conducting, and disseminating workshop results. Taken from <http://www.setac.org/node/104>

Although the term “pollinators” encompasses a broad number of taxa, for the purposes of this SETAC Workshop and its proceedings, the term “pollinators” refers specifically to subspecies and strains of *Apis mellifera* that originated in Europe (i.e., the honey bee) and other (non-*Apis mellifera*) bees, for example, bumble bees, solitary bees, and stingless bees. The Workshop built upon the numerous efforts of different organizations, regulatory authorities, and individuals, both nationally and internationally, aiming to better understand the role and effects of pesticide products on honey bees² and other bee species.

1.1 WORKSHOP BALANCE AND COMPOSITION

Similar to other timely and relevant scientific issues addressed by SETAC Pellston Workshops, the issue of pollinator protection is of high interest to scientists employed by governments, business, academia, and nongovernmental organizations. For this reason, SETAC requires that its workshops be similarly balanced. The Workshop on Pesticide Risk Assessment for Pollinators represented an exceptionally diverse composition by both sector (employer) and geography. The 48 participants (35 panelists and 13 Steering Committee members) included individuals from industry, nongovernmental organizations, federal and state governments, the beekeeping community, and academia and represented five continents (South America, Europe, Australia, North America, and Africa) (see Acknowledgments).

This proceeding of the Workshop on Pesticide Risk Assessment for Pollinators has several sections:

- Chapters 2–6 provide background and overview of key elements such as bee biology, ecological risk assessment, and protection goals.
- Chapters 7–10 capture recommendations by the Workshop on the elements of exposure assessment, effects assessment (laboratory and field testing), and risk assessment.
- Chapters 11–14 capture discussion around statistical analysis, modeling, risk management, and research needs.

Pollinators, and the honey bee in particular, have been identified as a valued group of organisms because of the services they provide to agriculture and to ecosystem biodiversity. While both managed and unmanaged (*Apis* and non-*Apis*) bees contribute to crop pollination, most of the current knowledge of the side effects of agricultural pesticides on pollinators is in relation to the honey bee. Since it is not possible to test all species, regulatory authorities rely on one or several surrogate species to represent a wider range of species within a taxon. Unlike the North American process that uses the honey bee as a surrogate for other terrestrial invertebrates, the European process includes testing requirements for honey bees specifically (representing pollinating insects), and includes other surrogate test species for nontarget arthropods in general. The proposed process discussed herein relies mainly on the honey bee, but includes other species, such as bumble bees, for example, to represent the many different species of bees. Therefore, it is important to understand the ecology and biology of the *Apis* bee as a test organism, as well as that of non-*Apis* bees.

² USDA Technical Working Group Report on Honey Bee Toxicity Testing, July 8 and 9, 2009, http://www.aphis.usda.gov/plant_health/plant_pest_info/honey_bees/downloads/twg_report_july_2010.pdf; International Commission for Plant–Bee Relationships 10th International Symposium, 2009, <http://www.uoguelph.ca/icpbr/pubs/2008%20ICPBR%20symposium%20archives%20Pesticides.pdf>